Handset Testing to the New Standards for Hearing Aid Interface

Bob Zurek

Motorola PCS Core Technology and Advanced Concepts Research

Telephone Hearing Aid Interface

- Two methods to receive audio signal from phone: acoustic or magnetic
- Acoustic mode - microphone picks up acoustic signal from telephone receiver.
- Magnetic mode – Telecoil picks up alternating magnetic field
- Magnetic source is receiver voice coil, internal wire loop, or external neck loop.

Wireless Device to Hearing Aid Interference

- **Two conditions for undesired RF disturbance:**
  - Far-Field condition (bystander compatibility) - bystander experiences disturbance due to adjacent WD user.
  - Near-Field condition (user compatibility) – hearing aid equipped user of WD experiences disturbance.
- **RF E & H field produced by digital wireless device (WD) induces noise in hearing aid through telecoil or circuitry.**

Mechanisms of Interference

- **Reception through telecoil**
  - Magnetic signal being picked up
  - same method as desired audio coupling in telecoil.
- **Reception through circuitry**
  - Can be electric or magnetic field induced.
  - Typical way noise induced in circuitry is via microphone wires.
  - Biased FET in microphone rectifies RF signal.
  - RF being transmitted induces non-zero dc voltage; RF not being transmitted results in zero volts.
  - Resultant interference is a square wave with f_o equal to RF pulsing frequency. (217 Hz for GSM, 50 Hz for TDMA, etc.)

Standard History

- **In the past standards were for either a hearing aid or a telephone.**
- **Hearing aids were subjected to interference tests.**
  - Predominately for far-field bystander testing.
  - WD user testing virtually ignored.
  - Standard example: IEC 60118
- **Telephone tests were predominately for HA compatibility.**
  - Axial/radial field intensity
  - Induced frequency response
  - Standard examples: FCC 47 CFR 68.316, EIA RS-504, IEEE1027

Standard History (cont.)

- **In 1995 US FCC initiated steering committee to find resolution to WD/HA interference problem.**
- **January 1996 ANSI C63 was petitioned to undertake joint standards project.**
- **April 1996 ANSI C63 established task group TC C63.19 under its subcommittee on medical devices.**
  - Charged to develop standards with cooperation of representatives of people with hearing loss, hearing aid manufacturers, digital wireless telephone industry, & other interested parties
  - Standard to consist of methods of measurement and definition of limits for hearing aid compatibility.
- **ANSI C63.19-2001 "American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids" was approved 2 May 2001.**

Substance of C63.19-2001

- **The intent of the standard is to establish categories for both WDs and hearings aids that will indicate which hearing aids are compatible with which WDs.**
- **The categories represent usability in "audio coupling mode," and in "audio band magnetic coupling mode."**
- **Individual usability ratings are not meaningful by themselves, only when combined for system performance classification.**

Substance of C63.19-2001 (cont.)

- **In audio coupling mode:**
  - Usability "U" categories are determined for WD and hearing aid.
  - U1 lowest usability - U4 highest usability
  - Both U categories are summed to determine system performance classification.
  - System classifications are: (4)usable, (5)normal use, and (>=6)excellent performance.
- **To be rated for T-coil use, a "T" is added to the Audio coupling mode "U" rating if:**
  - the hearing aid meets specified near field immunity levels
  - if the WD meets specified signal quality levels.

Tests Defined in C63.19-2001

- **Wireless Device (WD) measurements:**
  - RF E-Field emissions
  - RF H-Field emissions
  - T-coil mode, magnetic signal strength in the audio band
  - T-coil mode, magnetic signal & noise articulation index
  - T-coil mode, magnetic signal frequency response through the audio band.
- **Hearing Aid measurements:**
  - RF immunity in microphone mode
  - RF immunity in T-coil mode

WD RF Emissions Test

- **Phone transmitting at maximum output power.**
- **Test area is scanned for highest E and H field strength**
- **Can use 3 orthogonal probes or single probe aligned to maximum field at each point**
- **5 cm x 5 cm test scan surface**
  - 1cm above WD reference plane
  - Begins at top of WD
  - Centered about the center line of the WD
  - Covers WD receiver area
  - Subdivided into 9 subgrids (3 contiguous subgrids on edge may be excluded.
- **Highest field strength in remaining 6 subgrids determines category rating.**

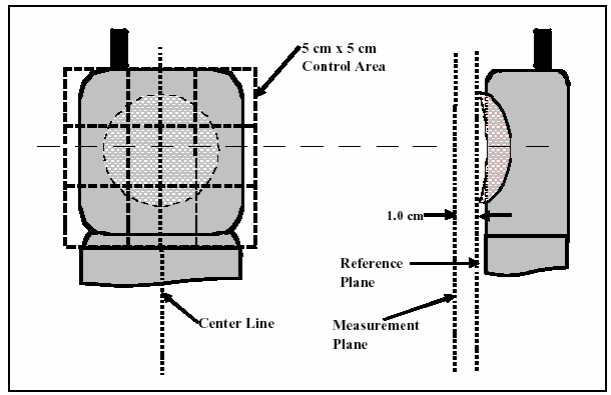


Figure A.2—WD reference and plane for RF emission measurements

WD RF Emissions Test

- **Lowest category ranking from either E or H field determines the overall WD category.**
- **Category limits are weighted with an AWF.**
- **AWF based on degradation of intelligibility due to spectral content of interference.**
- **This is the only part of the standard that is mandatory for the WD.**

Table 1—Hearing aid and telephone near-field parameters

RF Parameters				
Category	Hearing aid parameters (Hearing aid must maintain <55 dB IRIL interference level and <6 dB gain compression)		Telephone parameters	
Near field	E-field immunity (CW dB (V/m))	H-field immunity (CW dB (A/m))	E-field emissions (CW dB (V/m))	H-field emissions (CW dB (A/m))
Category U1	30.0 – 35.0 dB (V/m)	-23.0 – -18.0 dB (A/m)	46 – 51 dB (V/m) + 0.5 × AWF	-4.4 – 0.6 dB (A/m) + 0.5 × AWF
Category U2	35.0 – 40.0 dB (V/m)	-18.0 – -13.0 dB (A/m)	41 – 46 dB (V/m) + 0.5 × AWF	-9.4 – -4.4 dB (A/m) + 0.5 × AWF
Category U3	40.0 – 45.0 dB (V/m)	-13.0 – -8.0 dB (A/m)	36 – 41 dB (V/m) + 0.5 × AWF	-14.4 – -9.4 dB (A/m) + 0.5 × AWF
Category U4	> 45.0 dB (V/m)	> -8.0 dB (A/m)	< 36 dB (V/m) + 0.5 × AWF	< -14.4 dB (A/m) + 0.5 × AWF
Category UX	special	special	special	special

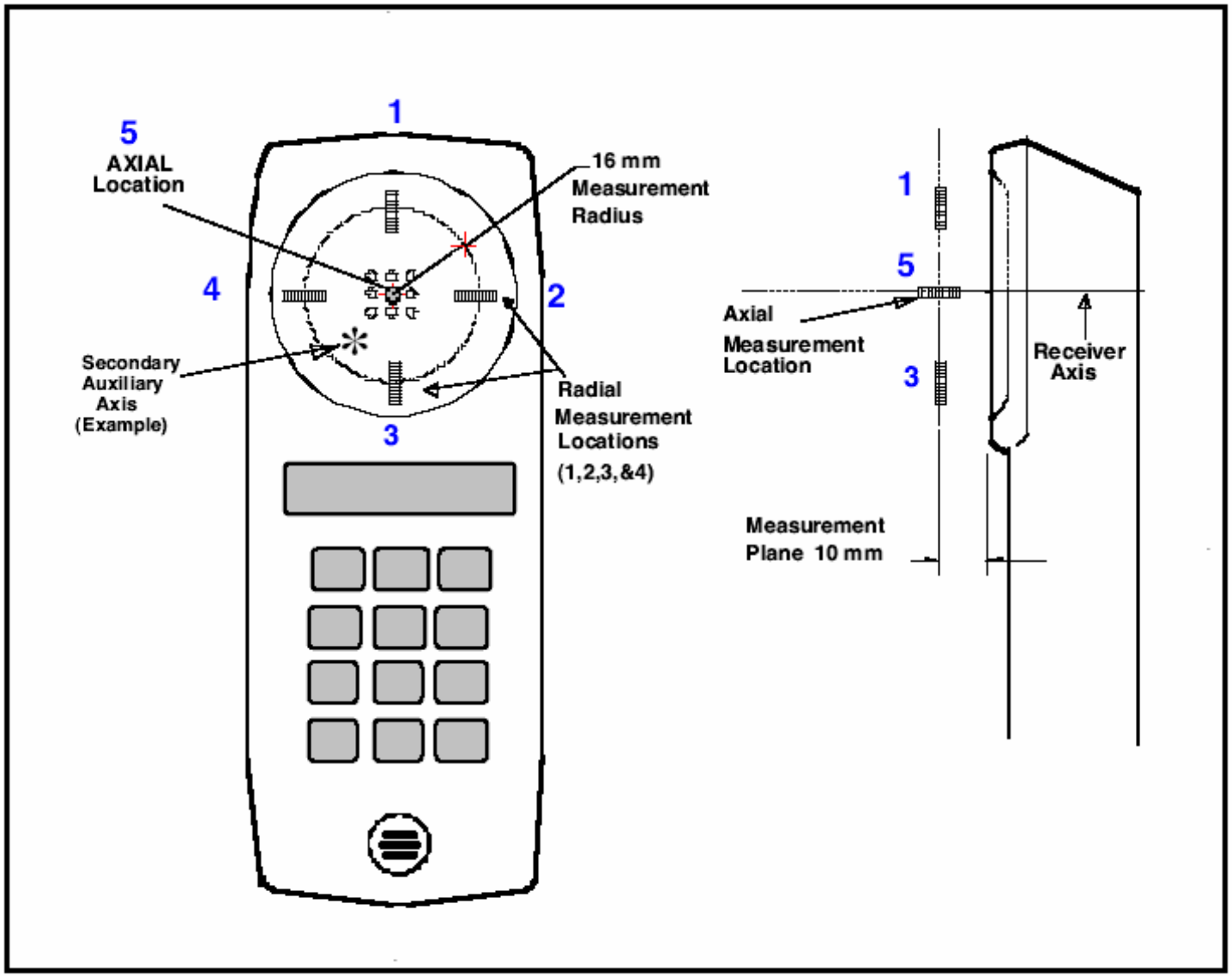
Standard	Technology	AWF
TIA/EIA 553-A	Analog	0
IS-95	CDMA	0
IS-136	TDMA (50 Hz)	0
J-STD-007	GSM (217 Hz)	–5

WD Audio Band Magnetic Emissions

- Recommended test, not mandatory.
- All tests use a standard telecoil mounted 1cm above reference plane.
- Telecoil defined in C63.19-2001 annex D.13 and IEEE 1027-1996 clause 4.2.1
- Phone is tested with RF power set to maximum, but with the WD antenna replaced with a coax to mask the RF transmission signal from the measurements.
- Signal is introduced as P.50 for digital phones using a base station simulator, or sine tone in the sidetone or loopback path if in manufacturer test mode.

WD Audio Band Magnetic Emissions

- **Set drive level to produce 94dBSPL (0dBPa) into ear simulator at 1kHz 1/3 octave band.**
- **Measure desired audio band magnetic signals (ABM1)**
  - At ISO 1/3 octave frequencies.
  - Measure at 5 positions: 4 radial, 1 axial
- **Measure undesired audio band magnetic signals (ABM2)**
  - Measure at axial point.
  - A-weighted



ure A.3—Axis and planes for WD audio frequency magnetic field measureme

WD Audio Band Magnetic Emissions

- **Audio Band magnetic coupling field intensity**
  - Has no bearing on UT classification
  - Axial component shall exceed –13dB(A/m) @1kHz for 0dB(Pa) drive level
  - Radial component shall exceed –18dB(A/m) @1kHz for 0dB(Pa) drive level
  - For landline phones, FCC 47 CFR 68.316 requires axial component to exceed –22dB(A/m) @1kHz for equivalent of –4dB(Pa), and radial component to exceed –27dB(A/m) @1kHz
- **Frequency response**
  - Has no bearing on UT classification
  - Axial component of magnetic field shall follow response curve specified in EIA RS-504-1983

WD Audio Band Magnetic Emissions

- **Signal quality**
  - Difference of axial desired magnetic field (ABM1) @1kHz and axial undesired magnetic field (ABM2)
  - Category limits are weighted with an AWF.
  - Sign error in clause 7.3.3 has opposite effect of intent of AWF.

Table 3—Magnetic coupling parameters

Magnetic coupling parameters		
Category	Hearing aid parameters	Telephone parameters
	Near field immunity (w/27.8 dBm CW into dipole)	WD signal quality (Signal + noise-to-noise ratio in dB)
Category U1T	75 – 85 dB (IRIL)	-10 – -20 dB + AWF
Category U2T	65 – 75 dB (IRIL)	0 – -10 dB + AWF
Category U3T	55 – 65 dB (IRIL)	10 – 0 dB + AWF
Category U4T	< 55 dB (IRIL)	> 10 dB + AWF
Category UXT	special	special

Standard	Technology	AWF
TIA/EIA 553-A	Analog	0
IS-95	CDMA	0
IS-136	TDMA (50 Hz)	0
J-STD-007	GSM (217 Hz)	–5